A NEW PARADIGM IN ENGINEERING EDUCATION IN PUC-RS

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Abstract- *The technology evolution is having an exponential growing nowadays, while the teaching methods are having a linear growing. That difference produces a gap between them and is growing faster and faster. Thus, It is necessary to perform some kind of program to avoid that. This paper presents the implantation of a pilot program of the new engineering education paradigm in the Engineering College of PUC-RS.*

Introduction

Nowadays all enterprises are worried with quality in their products and their services, seeing better serve their customers and survive through the challenges of the third millennium. The Universities can not stay out of this world tendency too. With this we tried to identify criteria that verify the efficiency and the quality in the engineering teaching, getting a graph (Figure 1) that represents the evolution of technology and the engineering teaching.

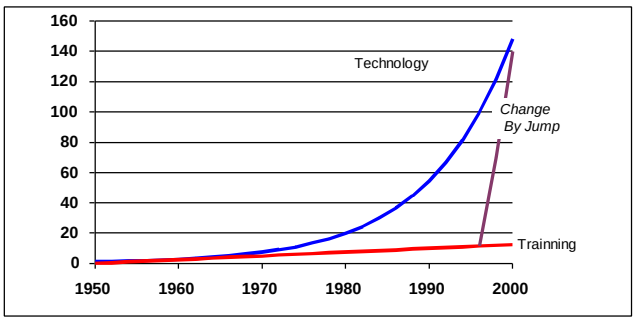

Figure 1 Technology Evolution and Engineering Teaching

That comparison led us to perceive a gap between technology evolution (that is an exponential growing law) and teaching methods evolution (that is a linear law of growing). Since an exponential law grows faster than a linear law we verify that the gap is increasing and the tendency is to be bigger if we do not make something.

Oriented through this thought, the authors have dedicated efforts to contribute in the solution for this gap, throughout publications of many papers in congresses about teaching and learning.

The last paper (published in COBENGE-97), refer to a research project that intend to know the perception of the engineering professors about the teaching and learning process and to identify the actual education paradigm that orient the engineering teaching.

In the next congresses (COBENGES) will be presented the results of that research and the new proposal methods for the engineering teaching in accordance with the twenty-first Century challenges.

As a pioneer, anticipating the results of the research, the PUC-RS University is implanting a pilot program of the new engineering education paradigm in the Engineering College.

The actual work intend to cover the following topics:

- To present a synthesis of the studies of papers published early about the issue teaching/learning in engineer;

- To present the partial results of the research until presentation of camera-ready manuscripts;

- To brief explain of the status of pilot program of the new engineering education paradigm implemented in the Engineering College of PUC-RS.

Study of the Learning

We will begin our work developing a theoretic base about the learning starting with the philosophic and psycho-pedagogic foundation.

The Human Perception

The experience that is related next was the impulse of the central idea presented in this text. It is based on concepts of

conservation and reversibility, quoted by Piaget [11], [12] and [13] to explain the stages of cognitive developing of children. The experience consists of put equal volume of water in different types of recipients with shape and dimension odds, like Figure 2.

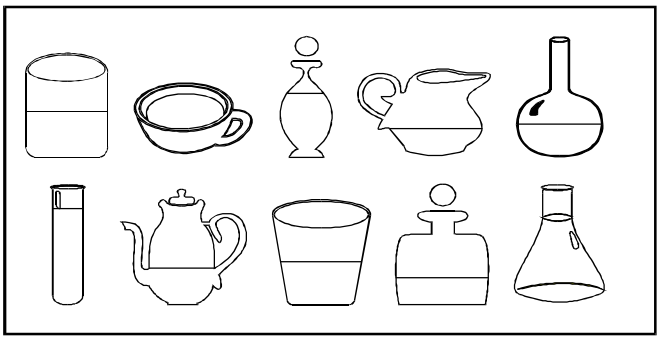

Figure 2 Experience based on Piaget.

In our case we decide accomplish it, by curiosity, with adults, intending to observe on what level their thoughts work. We presented the bottles with liquid in their interior, because we intend to discover if they were able to realize the conservation of volume in all bottles. When we ask them what bottle have more liquid, their answers diverged too, influenced by visual characteristics of all bottles, like what happened with children in the original experience made by Piaget. That experience, accomplished with different groups, confirmed the impossibility of adults to realize, only visually, the conservation of the volume of water. We modified the experience next time, transferring 20% of the volume of water from one bottle to the other one and, once more, no one could identify what bottles have more and less liquid.

From this simple experience, it follows that the human beings have difficulty to distinguish a constant among variables. In the experience, there were ten variables (ten kinds of bottles) and a constant (the liquid's extent). Thus, we can't simply trust on our sensorial perception when we need to see, into some context, a constant among variables (or a variable among others variables). Spoken in other way, it's not safe to trust in our own opinion as a single criterion to evaluate the reality or as a single source of knowledge.

The reader could ask itself (and we suggest you to do it if you didn't make it yet) what is the relation between the result of this experience and the teaching of engineering. That is precisely from this point on, in spite of it's apparent insignificance, that we will get to understand many things about the problems suddenly appear to the teacher in its pedagogic making. To elucidate our thinking line, we solicit that the reader asks itself the following question: in the engineering teaching context, involving many variables (technologic, humans, socials and others), what are the ones that define the learning phenomenon? When we do this question to a group of teachers we watch the same principle repeat itself in this new context, alike the bottles with water experience. Each one said that the learning is this or that, diverging significantly their opinions about how occurs such phenomenon. However, it is worth marking that the mistake in this situation implicates in consequences of more complex dimensions. The Bottles situation, although it is concrete and visible, causes a sort of confusion, which one is easily undid, being necessary for that the use of a standard measure to verify the real liquid's extent into the bottles. However, the learning, as a human phenomenon, is extremely complex; it isn't something concrete and visible; it is much harder to perceive which are the real variables that are in the game. Not knowing which are these variables, the traditional scientific criterion to measure the learning can't be used, as we do to know which bottle contains more water.

These experiences help us to understand the impossibility of orientates our pedagogical actions based only on the opinion of how occurs the teaching and learning process. We also have in mind ourselves about the necessity of discovering what are the variables that define the learning. Not being possible to discover this in the criterion of the opinion, we try the reading of different authors to supply this job, that is, we evolve from the amateur criterion, from the opinion category, to the authority criterion. In the searching of a method or way, to find which variables define the learning, it showed itself necessary to incorporate the theory's concept as it is formulated

The Necessity of a Theory

Raths was the first author who help us to understand the necessity of a theory to orient our pedagogic actions, when he defined it, in his book Learn to think, so "...theory mean a relationship among two or more variables, with the effort to define them" [14]. While the Piaget's experience suggests us the necessity of some kind of guide to allow us to discriminate a variable among others, Raths offer us that recourse with his theory concept. With this guide, we can continue our way to discover how the learning phenomenon occurs: we only need to discover which are the variables and how they may be related to configure a theory of learning. Bigge [2] consolidate in us the conviction of the necessity of have a theory, rather than the opinion, to orient our actions, when said "The action, being part of the learning process, being part of any activity in life, is attached to a theory, or is blind and without goal. Consequently, any action with goal is determined by a theory; "a professor who does not use a systematic theoretic body in his daily decisions is blindly acting"; "...a professor without solid theoretic orientation hardly ever can go beyond hold the student busy"; this confuse manner of teach is no doubly responsible by many negative critics that are made to the public education nowadays [2].

The Learning Theories

We found out the answer about which variables define a theory of learning, in a study made by Bigge, the same author quoted above, about the historic/philosophic developing of man. He indicate two variables only, as that ones that establish the existing learning theories. They are the moral nature of man and the action nature of man.

The man, in his moral nature, depending upon the philosophic conception, can be classified according to these basic tends: bad, good and neutral. As the nature of his action, the man can be classified as: active, passive and interact.

From the relation two-to-two of these variables originate, along the history of knowing of the philosophy, psychology and education, the main theories of teaching/learning. There are nine possibilities of combination of these variables, however only five generate possible learning theories. As Bigge said, from the five combinations given, develop the big learning fails, which derive ten learning theories.

From this study, we try to identify, through many hypotheses, which one of these existing learning theories would be based the engineering teaching [15].

What we conclude that time, in synthesis, is that the engineering teaching is not founded in any learning theory [RIB94]. Since we do not identify the variables (as the thoughts of Piaget, Raths... e Bigge), it is not possible to configure a theory. So, we cannot attribute efficiency to engineering teaching, because it's not theoretical, that is, it is oriented based on the opinion and not founded in a theory. We alert, yet, to the serious implications psychosocial following that thought not theoretical [4]. We need here salient to the valve and importance of the second part of this work, when we propose a research, to be achieve with the engineer professors, to investigate the hypothesis above.

The Learning Paradigms

Following the study line above, we found out in the paper "Ruptura com o Construtivismo Piagetiano" [7], the theoretical diagrams that, as we see, synthesize the various learning theories presented by Bigge. In the Figure 3, we show those theoretical learning diagrams, where each one represent a flow of thinking with similar epistemology roots. According to this paper a long time ago the third one, the constructive learning paradigm, overcame the first two epistemology picture frames. This one is being increased nowadays by the model constructive pos-Piaget, more complete than that one.

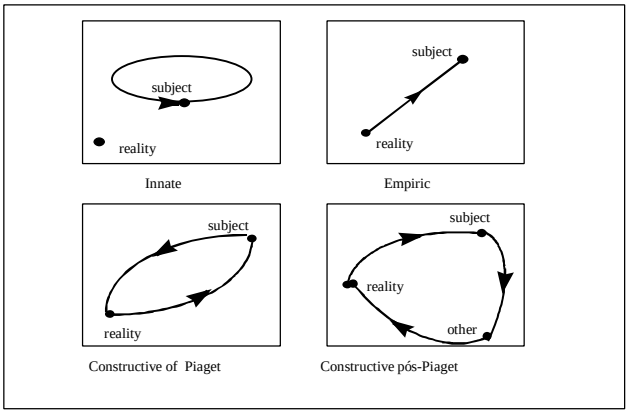

Figure 3 Frames Theoretical of Learning

Another reference, that follow that line of thinking, is the book of Vygotsky [20] about the social mind building, where his research about the superior psychology process development confirm the overcome over the first three. He calls the innate of botanical paradigm, because it utilizes the botanical analogy to describe how children learn. The next step rising in the scientific explanation, Vygotsky called empiric of zoological paradigm, once it bases in zoological models to explain the learning. To overcome the limitations of this models, he teach us how occurs the superior psychological process development, that, in synthesis, is what Grossi [7] presents as an epistemology frame of constructive pos-Piaget. To illustrate the evolution scale of the learning paradigms suggest by Vygotsky, we create the diagram in shape of stair showed in Figure 4.

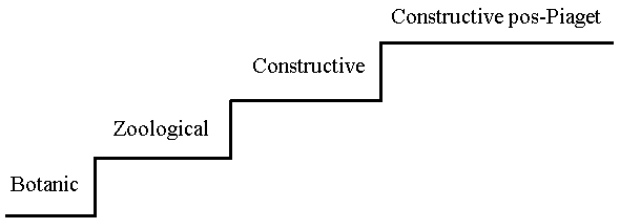

Figure 4 The Learning Paradigms

The learning paradigms in a similar way of that verified in the study of learning theories, cannot ....the engineer teaching in any one of the epistemic frames showed above. However, as said by Ribas in "Um Novo Paradigma em Treinamento" [16] and "Aprendizagem, o Segredo da Transformação" [17], it is possible to identify the influence of the empiric, as in the industrial training as in the engineer teaching. The adverse consequences are evidenced too, when we use that zoological paradigm in the teaching activities, specially the resistance of people to the new paradigms. That resistance, resulting from the conditioning (basic principle of the empiric), restrict the behavior on actions ridges and mechanics and, at the same time, obfuscate the perception of other paradigms more adequate to explain how we learn.

Here we can salient, like Ribas and Comiotto [4], alert to the psychosocial implications due to the use of that engineer teaching paradigm, beyond it's proved inefficiency, as [16] and [17].

Psychopedagogic Contribution

The goal of the psycho-pedagogy is help people with learning problems. To achieve that, it has to know why people do not learn. To know why somebody do not learn, it is needed to know very well how to learn. So we think opportune the contribution of psycho-pedagogy to better understand the learning in the context of engineer teaching. Alícia Fernandez, in her book "A Inteligência Aprisionada" [5], teach us that the fail in learning can have origin in two kinds of problems: reactive learning problem and symptomatic learning problem. The first one, refer to the fail of the teacher (professor) and the education system; it is a wide problem, since affect the most learners (pupils). The second one, originate from things related with aspects of the structure of the learner and with external aspects of the education system, it is an individual problem. When the educative fail occurs by reactive learning problems, it has origins out of the learner.

We must, thus, seek its causes out of the pupil, it is being the education system one of the mains. We think that the specific case of engineer teaching frames itself in this situation. This reinforce our anterior position, when we doubt about the efficiency of engineering teaching, due to the pedagogic make of its professor.

The Way That Orient This Work

The discussion of questions above, certainly are very polemics. To want to discuss, however based upon the popular amateur criterion of the opinion, beyond be a waste of time and energy, is an ineffective solution, as we consult many authorities in the issue, through reads in books and participating in specializes courses. In this way, we get develop from the amateur (opinion) category to the authority criteria.

Table 1 Known Classification

Criterion	Category	Characterization
Amateur	Opinion	I think that "p"
Authority	Quoted	Like the author "x"
Scientific	Evidence	Like research "y"

The next step, once we develop from the amateur criteria to the authority criteria, is to go to the scientific criteria, as according to knowing classification suggest by Table 1. We did that classification, from what we learned with bottle experience about the limitations of the opinion, amplified through the following Bigge suggest: "Think by yourself is never easy. However, you will be able to accomplish a respectable work of critic think if you are perfectly informed about two antagonistic criteria to judge answers for the formulated questions: the authority criteria and the scientific criteria [2].

So, to develop from the opinion to the scientific criteria, mediate by the authority criteria, is the way that orients this work and that motivate us to propose a research project about the perception that the engineering professor has about teaching and learning process. With this, we seek the scientific known a step above of that one build till here, to elucidate the learning problem in the engineering teaching.

The Teaching Learning Process in Engineering

Introduction and Justification

The ideas enclosed in the anterior part of this work are sufficient to us to justify the necessity of the scientific known, through out the research, that will be founded in results from the engineers themselves, as engineering professors. No one better to talk about a situation than who lives it; thus no one better to talk about teaching and learning process in engineering than the professor who lives serious problems in his daily. Because he did not receive any didactic formation, the professor of engineering reproduces, as a professor, the model of his ancient professors. His teach practice become reproductive by do not know how to turn it dynamic, fruit of the action-reflection adjacent, where the known is not given but is produced; it is built from the action of the professor and the student, like a constructive pos-Piaget model studied.

Goals

In synthesis the present work intends to study the following topics:

- To present a synthesis of the studies of papers published early about the issue teaching and learning engineering;

- To present the partial results of the research until presentation of the final text date;

- To present a brief explain of the status of pilot program of the new engineering education paradigm implemented in the Engineering College of PUC-RS.

Theoretic Referential

From the study presented in the first part of this work, we intend, in the goes by of all investigation, grant its with the theoretical support of the several sources that support the act of teach and learn, as well as the process while conjunct action, where there is no one who has the power of teach and one who has the obligation of learn, but where professor and student together create and recreate act of learn and teach.

Partial Results of the Research Till Now

The data for that investigation are being obtained from a questionnaire distributed among the professors of the college of engineering of PUC-RS in the courses of Civil, Electrical, Mechanical and Chemical Engineering.

The questionnaire is formed by close and open questions. The close ones are being submitted to the statistic treatment and the open ones to the content analysis and interpretation suggested by Bardin [1]. This author proposes three distinct moments to proceed the content analysis: pre-analysis, exploration of the material and analysis and interpretation of data. As a result of those three moments, come the categories that translate the thinking of the people who answer the questions about the theme proposed by investigation.

As questions that orient this investigation, we can salient that we want:

- To identify the distinct perceptions of engineering professors about the teaching and learning process.

- To evidence the more significant perceptions about the theme in research, among the professors interviewed.

- To evidence the more significant methodological worries of professors, when developing their teaching and learning process.

- To evidence, if exist, the learning theories that contribute in the engineering teaching in state, regional and national wide ambit.

- To elaborate lines of psycho-pedagogic actions that include the necessity of professors involved in the teaching and learning process.

- To contribute with the teaching and learning process in engineering, supporting its professors with a methodological propose to increase the pedagogic practice.

Report of Experience of Pilot Program Implantation of the New Teaching Paradigm in Engineering College in PUC-RS

Until the present moment we have three professors applying the new teaching paradigm in electrical engineering course in engineering college in PUC-RS in approximately six classes that are from the fifth to seventh semester of the course. These professors had a previous training during the vacation months to be able to initiate the use of new teaching paradigm in their classes.

The dean of engineering college of PUC-RS is analyzing a course proposal about the new teaching paradigm to be applied to a significant set of professors of all engineering departments (we think eighteen professors) that must start the August of this year.

It is still too soon to publish the results that can be used to compare the new teaching paradigm with the old one, because these classes began their activities only in the beginning of march and till the moment had only one evaluation accomplished in the way of the new paradigm, that is equal to one tenth of the full semester evaluation. However some professors comment that is having an active participation of the students and that ones who did not dedicate to study some classes are now trying to learn the contents to accomplish all the goals proposed by professors.

CONCLUSION

It is undoubted the importance of a minimum known of the teaching and learning process, for a responsible efficient and effective acting, of the engineering professor. Conscious of that we presented a summary of our study about teaching and learning process, where we emphasize the epistemology differences among the distinct paradigms on how the learning occurs. We hope, with this, contribute to conscious the professors of their role and responsibility as agents of reproduction of the education mandates implicit in these paradigms.

To make concrete our contribution to the engineering teaching, lined with the perspective before, we propose the realization of a research project to know what educational paradigm is orienting the pedagogic practice of engineering professors and which are their perceptions of the teaching and learning process. The results that will be get from this research will establish a scientific reference about the theme researched, turning possible methodological proposes founded in data extract from the reality and founded in proper theoretic references.

The engineering work with contents of scientific area and the importance of those services are priceless. So, it is incompatible with the principles of that science restrict their pedagogic make to the amateur category (simple opinion), with all problems that results from that. With out the necessary scientific known about the teaching and learning process. In this sense we salient the importance of this work, bringing up to discussion in this conference scientific data about teach and learn, theme that worry all participants of this event.

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